CIRCULAR No. 375 DECEMBER 1935
UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

VARIETAL SUITABILITY OF PEACHES FOR PRESERVE MAKING AND FACTORS AFFECTING THE QUALITY OF THE PRODUCT

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INTRODUCTION

For a number of years, peach growers in the Eastern States have been faced with the problem of a varying but usually considerable excess of production over the demands of the fresh-fruit market. The existence of this problem has led to awakened interest in the application of various methods of preservation to the numerous varieties of peaches grown primarily for consumption in the fresh state. In a number of instances the preservation of the fruit, without regard to variety, has been undertaken upon a rather large scale.

The disappointing results of such attempts have emphasized the impossibility of applying routine methods of preservation to miscellaneous groups of varieties with any expectation of uniform success, and have shown the consequent necessity of experimental study of the problem of varietal suitability to various methods of utilization. They have also shown that very closely related varieties, or those that appear essentially identical in all their characters, may display the widest possible differences in their response to a given preservative treatment. Consequently, it is impossible from inspection of any particular variety to forecast whether it will prove to be good, indifferent, or poor material for preserving purposes, or good for one purpose and poor for another. The usual chemical analysis also fails to furnish dependable information as to what the behavior of a variety will be under a given treatment, as the results depend to a considerable degree upon the reactions of constituents present only as traces and not determined in the analysis. The composition of some of these constituents and the conditions

which bring about alterations in them, as, for example, the substances responsible for specific odors and flavors, are very imperfectly known, and the presence and degree of activity of enzymes can be measured only by the results of their action.

The most satisfactory method of studying the problem would appear to be the assembling of a large number of varieties representing the whole range of cultivated peaches and the systematic testing of each variety, under controlled experimental conditions, as to its suitability for various methods of preservation. When accompanied by physical and chemical studies of the fruit and of the changes occurring during the ripening process, such studies should yield information of immediate practical value to canners, preservers, and others utilizing the material for manufacturing purposes, and should also contribute to an understanding of the specific factors or combinations of factors that determine the suitability of the fruit for any particular purpose.

This method has been employed in this laboratory in comparative studies of the suitability of groups of varieties for canning (*9*),[1] for the making of pulp for use in ice cream (*10*), and for freezing in consumer packages for use as dessert fruit (*4*, *5*, *6*). Similar varietal studies of freezing of peaches for dessert use have been made by Woodroof (*17*) and for use in ice creams and ices by Cruess and his associates (*7*, *8*, *15*) and by Mack and Fellers (*11*). The general results of these studies have emphasized the high degree of individuality existing in varieties with respect to the preservation of desirable qualities of color, texture, and flavor under various preservative treatments.

The present paper reports a continuation of the earlier studies (*5*, *6*), the primary purpose of the work being to determine the varieties best suited for preserve making, the combinations of factors and qualities which tend to give the highest quality in the product, and the effect of stage of maturity upon quality of product. Some attention was also given to the effects of varying the proportions of fruit to sugar and of varying length of boiling time, so as to give various final concentrations of sugar in the mixture.

MATERIALS AND METHODS

Sixty-seven varieties of peaches were employed in the work. Approximately 40 of these were peaches grown primarily for dessert purposes and having at ripeness flesh of the soft, melting type; about 20 were clingstone varieties grown primarily or solely for canning and having firm-textured flesh of the resilient character termed by Blake and his associates nonmelting (*1*, *14*); and the remainder were intermediate or semimelting in character of flesh. The dessert group included white-, yellow-, and red-fleshed varieties of both free and cling types and contained most of the important commercial varieties, many of the older home-orchard sorts, and a number of recent domestic and foreign introductions. Fifty of the sixty-seven varieties have previously been studied in this laboratory with respect to their suitability for freezing in small containers for use as dessert fruit (*6*).

[1] Italic numbers in parentheses refer to Literature Cited, p. 21.

The fruit employed in the experiments was for the most part obtained from the peach varietal orchard at Arlington Experiment Farm, Rosslyn, Va. The trees were all in good vigorous growth and ranged from 5 to 7 years of age. All varieties had set a heavy crop, necessitating the removal of one-half to two-thirds of the fruit in thinning. This left a normal load of medium to moderately large fruit on the trees. Fruits of a number of varieties were obtained from the varietal collections of the University of Maryland at College Park, Md. The trees ranged from 4 to 8 years of age, were in good vigorous condition, and bore moderate to fairly heavy loads of fruit of good size.

In the comparative study of varieties an especial effort was made to use fruit of as nearly as possible a uniform stage of maturity. The stage chosen was that reached 2 to 4 days after commercial picking ripeness (shipping ripeness). This is the stage found by Culpepper and Caldwell to give best quality in canning the melting-fleshed varieties (*9, pp. 27–30*). At this stage practically all green color has disappeared from the flesh and has been replaced in the yellow-fleshed varieties by a fairly pronounced yellow. The characteristic aroma and flavor of the variety is fairly well developed. The flesh has softened very appreciably throughout, especially toward the tip and along the suture line, but is still firm enough to peel readily in boiling lye solution without crushing or shredding.

In order to secure the desired uniformity in the material used, the orchards were visited daily throughout the season and the date of attainment of shipping ripeness was noted for each variety. The samples were picked a definite number of days after the date of shipping ripeness by the experimenters themselves, who selected as closely as possible for uniformity in ripeness. Samples of ample size were taken, and the fruit was again carefully graded for uniformity after reaching the laboratory.

In the case of a number of varieties, lots of fruit were also picked at several stages of ripeness ranging from 1 to 2 days before to 5 or 6 days after shipping ripeness, in order to determine the effect of the stage of maturity upon the quality of the product.

The fruit was usually picked between 8 and 10 a. m., immediately transferred to the laboratory, and worked up during the same day. In a few instances the numbers of samples obtained were too large to permit working up the same day; in such cases the fruit was held overnight in storage at 32° F. and used the next morning.

After grading, the fruit was peeled by immersion in boiling 2-percent caustic soda (commercial concentrated lye) or in some cases in an 8- or 10-percent solution heated to 135° to 140° F. It was then washed in running water to remove the lye and adhering shreds of peel. The stones were then removed and the fruit was sliced lengthwise into pieces one-fourth to three-eighths of an inch in thickness.

In all the material employed in the varietal comparisons, the preserves were made by the one-period open-kettle method, using equal amounts of fruit and sugar. The usual batch was one of 12 pounds. As soon as the requisite amount of fruit had been prepared, it was weighed into a large enamelware pan, the sugar mixed with it by stirring, a small quantity of water, usually 150 to 200

cc. was added to prevent scorching, and the pan was placed upon a large gas-fired hot plate of such construction that the heat was applied rather uniformly over the entire bottom of the pan. Gentle stirring with a glass rod was begun as soon as the heat was applied and was continued practically constantly throughout the cooking period, care being taken not to stir vigorously enough to crush or disintegrate the fruit. In order to secure greater uniformity in the cooking process the actual making of the preserves was done throughout by the same individual. A record was made of the time at which heating was begun, that at which the material reached a vigorous boil, and that at which the boiling was ended.

The boiling time ranged between 40 and 60 minutes, which is not excessive for the open-kettle single-period method of preserving. A thermometer was so placed in the vessel that the bulb was about one-half inch above the bottom of the pan, and the boiling was continued until the desired end-point temperature was reached. In all the material used in the varietal comparisons, the end point was 106° to 107° C., which, according to Gerlach, as quoted by Browne (*3*), would indicate a concentration of 69 to 71 percent in a pure sugar solution. It is probably somewhat higher than the end point commercially used for the open-kettle one-period process, for which Cruess suggests an end point of approximately 220° F. (*15, p. 292*). The end point used was chosen after some preliminary experiments in which it was found that a considerable number of varieties gave products distinctly too liquid if boiling were discontinued at a lower temperature. In certain tests the end point of boiling was intentionally varied over the range 104° to 110° C., in order to determine the effect of varying this factor when other factors were kept constant.

At the end of the boiling period, the pan and contents were quickly weighed to ascertain yield, and the material was then filled hot into previously sterilized fruit jars which were immediately sealed. The material was stored for 5 months at room temperature prior to examination and grading.

EXAMINATION AND GRADING OF THE MATERIAL

The factors considered in rating the material were color, texture and degree of disintegration of fruit, consistency, and flavor.

The Definitions and Standards for Food Products of the Food and Drug Administration (*16*) define fruit preserves as a "product made by cooking to a suitable consistence properly prepared fresh fruit, coldpack fruit, canned fruit, or a mixture of two or all of these with sugar or with sugar and dextrose, with or without water", and prescribe that not less than 45 pounds of fruit must be used to each 55 pounds of sugar. Approved code no. 460 of the National Recovery Administration (*13*) makes the same requirements as to proportions of fruit and sugar, mentions addition of spice, vinegar, and harmless organic acids as permissible, states that the product shall be cooked to a pulpy or semisolid consistency, and provides that when added pectin is used the finished product shall contain not less than 68 percent of water-soluble solids, as determined by refractometer at 20° C. As all the samples used in the varietal comparison were made from equal parts of fruit and sugar, had no added pectin, and were boiled to an end point indicating a

concentration of 69 to 71 percent of sugar, they fully conformed to these requirements insofar as the requirements are susceptible of measurement.

The provision in the definitions just quoted that the product shall be boiled to "suitable consistence" or to a "pulpy or semisolid consistency" leaves the factor of consistency open to individual judgment and consequently to differences of opinion. It seemed desirable to devise some more accurate method of determining differences in consistency than the usual one of manipulating the material with a spatula or spoon, pouring from one vessel to another, and the like.

The method for measuring consistency adopted for these tests employed a consistometer or penetrometer originally devised for measuring the consistency of greases and petrolatums in accordance with specifications of the American Society for Testing Materials for Test D-217-27T (*2*), with the difference that a special cone and attachments made of aluminum and so adjusted as to have a total weight of 50 g were substituted for those furnished with the instrument.[2] The cone was allowed to fall for 5 seconds, and the depth to which it penetrated, read from a scale graduated to 0.1 mm, was taken as the measure of the consistency. The penetration of the cone into the material and the scale readings decrease with increase in the consistency of the material. Readings were taken at a constant temperature of 60°F. The method was not wholly satisfactory because of the presence of pieces of fruit which varied in position and arrangement in the container, causing some variation in the readings. Rearrangement of the pieces of fruit so that wedging together could not occur was necessary in some of the nonmelting fleshed varieties. Each test was repeated a number of times, and the average of all readings was taken as the value for the sample. Values so obtained were generally in good agreement with the judgment of several individuals after manipulating the material with a spoon or spatula or pouring from the container.

In the determinations of color, texture or toughness, degree of disintegration, and flavor, the opinions of a number of persons were relied upon. These individuals independently examined and graded the material, and the final ratings are those arrived at by common agreement or by averaging where the ratings by individuals showed disagreement.

In order to simplify the work of comparison, each factor was rated on a numerical scale ranging from 1 to 10. In the case of disintegration of tissues, the fruit that held its shape most nearly perfect was given a rating of 1; ratings of 2, 3, 4, etc., denoting progressively increasing degrees of disintegration without regard to the question whether such disintegration was or was not desirable. Toughness of the pieces of fruit was considered undesirable, hence the most tender samples were given a rating of 1, increasing degrees of toughness receiving higher ratings. The degree of tenderness in the finished product and the amount of disintegration in cooking generally show inverse relations, fruit considered tough usually showing very little disintegration. In rating the other characters, attractiveness and desirability of the product were the

[2] Paul M. Williams, Bureau of Agricultural Economics, U. S. Department of Agriculture, has employed a similar modification of the grease and petrolatum penetrometer for measuring the consistency of canned corn and canned applesauce.

basis of the grading, the sample that was considered best in flavor receiving a rating of 1, the next best a rating of 2, and so on. The deepest yellow color seen in the material was considered most desirable; hence the depth and quality of the color was an important consideration in judging this character. The general yellow color was in many samples shaded with more or less dark brown, which was considered increasingly undesirable in proportion to its increase in amount.

The results of the examination and grading of the preserves made from the 67 varieties employed in the comparative tests are presented in table 1.

TABLE 1.—*Results of comparison of preserves made from the various varieties of peaches*

Group and variety	Type[1]	Date harvested	Stage of maturity after shipping ripeness	Time required to reach boiling point	Length of boiling period	Temperature at end of boiling period	Yield of total ingredients	Consistency value[2]	Color grade[3]	Disintegration of fruit[3]	Toughness[3]	Flavor[3]
			Days	*Minutes*	*Minutes*	°C.[4]	*Percent*					
Elbertalike:												
Augbert[5]	Y. F. M.	Sept. 6	0–2	18	42	107	78.1	33.5	1.5	3.5	1.5	2
Brackett	do	Aug. 23	2–3	30	42	107	78.6	33.8	2.5	2	3	1.5
Captain Ede	do	Aug. 15	2–3	30	63	107	80.2	30.9	4	3	2	2.5
Early Elberta	do	Aug. 11	2–3	25	46	106	80.2	34.2	1+	1	1.5	1
Elberta	do	Aug. 16	2–3	25	39	107	78.6	33.0	2.5	2.5	2	2.5
J. H. Hale	do	Aug. 19	2–3	27	48	107	79.7	31.6	4.5	6	2.5	5
Late Elberta	do	Sept. 5	1–3	25	35	107	80.7	32.0	1.5	4.5	1	1.5
McDevitt Cling	Y. C. M.	do	1–2	18	42	107	78.6	32.2	4.5	3	2	2
October Elberta	Y. F. M.	Aug. 25	2–3	24	42	107	81.2	31.1	4	1.5	4	4
Rosalind	Y. C. M.	Aug. 14	2–3	33	49	107	77.6	34.0	2	3	3	2
Smooth Hale	Y. F. M.	Aug. 19	2–3	25	47	107	79.7	30.9	4	5	2	5
Sutter Creek	Y. C. M.	Aug. 22	2–3	29	44	107	79.7	33.0	2	2.5	2.5	3
Wilma	Y. F. M.	Sept. 5	1–3	17	36	107	79.2	32.4	3.5	2	3	3
Golden Jubilee	do	July 24	0–3	27	70	106	78.5	35.1	5.5	4	1	5
Ideal	do	Aug. 7	0–3	30	43	106	80.2	36.4	1+	2.5	1.5	1
Up-to-Date	do	Aug. 9	2–3	37	57	106	78.6	36.7	3.5	2	1.5	1
Crawfordlike:												
Chairs	do	Aug. 25	2–3	28	50	107	78.6	34.0	5.5	1.5	3	3
Early Crawford	do	Aug. 8	2–3	38	55	106	81.8	34.5	4	3	2	1.5
Engle	do	Aug. 24	2–3	27	45	107	79.2	33.8	1.5	2	1	2
Foster	do	Aug. 29	2–3	21	54	107	79.2	34.1	1.5	2.5	1	1.5
Kalamazoo	do	Aug. 22	2–3	19	52	107	80.2	32.6	1.5	5	1	1.5
Late Crawford	do	Aug. 25	2–3	27	40	107	79.2	33.9	2	6	1	1.5
Niagara	do	Aug. 8	2–3	28	55	106	81.2	32.7	4.1	5	4	3.5
Reeves	do	Aug. 10	2–3	23	47	106	80.2	33.4	2.5	1	3	3.5
Rochester	do	Aug. 1	2–3	36	57	106	79.7	32.7	2.5	2	1.5	2
St. John	do	July 27	2–3	30	45	106	78.1	35.1	2	3	2	2
Slappey	do	July 28	3–5	37	51	106	79.1	32.1	2	2.5	1	1+
Miscellaneous:												
Banner	do	Sept. 5	2–3	17	38	107	78.1	33.0	5	1	2	3
Eclipse	do	Aug. 5	0–2	38	50	106	79.7	34.9	5	1	5	4.5
Krummel	do	Sept. 8	2–3	30	41	107	78.1	31.1	5	2.5	1.5	3
Massasoit	do	Aug. 3	3	35	60	106	79.3	34.6	1.5	1.5	2	2
Lovell	do	Sept. 7	2–5	28	36	107	80.7	30.5	2	2	1.5	4
Primrose	do	Aug. 16	2–3	25	46	107	81.2	31.0	7	3	4	5
N. J. 23322	do	July 31	3	31	44	106	81.2	34.1	3.5	3	1.5	3.5
N. J. 23515	do	Aug. 15	2–3	38	60	107	81.2	36.4	5	4	1.5	2
F. P. I. 68350	do	Aug. 28	2–3	25	30	107	80.7	34.9	1.5	3.5	1	1.5
Shamrock	do	Sept. 18	1–2	29	42	107	79.7	34.0	4.5	1.5	3.5	3

[1] Y. F. M.=Yellow freestone, melting-fleshed; Y. C. M.=yellow clingstone, melting-fleshed; Y. C. N. M.=yellow clingstone, nonmelting-fleshed; Y. C. S. M.=yellow clingstone, semimelting-fleshed. W. F. M.=white freestone, melting-fleshed; W. C. N. M.=white clingstone, nonmelting-fleshed; W. C. M.=white clingstone, melting-fleshed.

[2] Since the depth to which the penetrometer cone sinks into the material decreases with increasing density, high readings indicate thin consistency.

[3] Rated on scale of 1 to 10; see explanation on p. 5.

[4] Fahrenheit equivalents are as follows: 106° C.=222.8° F.; 106.5° C.=223.7° F.; 107° C.=224.6° F.; 108° C.=226.4° F.

[5] This variety has been cataloged and sold by several nurserymen under the name Roberta, which properly belongs to an older variety now no longer grown.

TABLE 1.—*Results of comparison of preserves made from the various varieties of peaches*—Continued

Group and variety	Type	Date harvested	Stage of maturity after shipping ripeness	Time required to reach boiling point	Length of boiling period	Temperature at end of boiling period	Yield of total ingredients	Consistency value	Color grade	Disintegration of fruit	Toughness	Flavor
			Days	*Minutes*	*Minutes*	*° C.*	*Per cent*					
Canning:												
A 1	Y. C. N. M.	Aug. 16	2–3	25	49	107	80.7	39.0	1.5	1	3	3
Dralle Golden	do	Aug. 22	2–3	27	47	107	79.2	34.0	1	1	2	2.5
Goodman Choice	do	Sept. 6	2–3	27	44	107	77.6	37.0	1.5	1.5	3	2
Golden Queen	do	do	2–3	20	47	107	78.6	32.2	1+	1	3	2
Levy (late)	do	Sept. 18	1–3	29	45	107	79.7	35.0	2	1.5	4	2.5
Orange Cling	do	Aug. 28	2–3	25	40	107	79.2	35.1	2	1	2	1.5
Peakes	do	Aug. 23	2–3	30	55	107	80.7	36.4	1.5	1	3	2.5
Phillips Cling	do	Sept. 6	3–4	22	43	107	80.2	35.5	1	1.5	2	2.5
Sellers	do	Aug. 22	2–3	27	43	107	81.8	33.5	1.5	1	2	2
Tuskena (Tuscan)	do	Aug. 7	0–2	40	55	106	80.2	35.0	1.5	1	1.5	1.5
Motion	Y. C. S. M.	Aug. 24	2–3	26	50	107	77.6	36.0	1	1	1.5	2
Paragon	do	Aug. 16	2–3	20	30	107	81.2	36.7	1+	1	1.5	1.5
F. P. I. 55563	Y. C. N. M.	Aug. 29	3–4	22	43	107	78.1	32.6	1	1	3	2
F. P. I. 55564	do	Aug. 30	0–2	15	42	107	79.7	33.6	1.5	1	1.5	1.5
F. P. I. 55836	do	Aug. 29	3–4	27	46	107	77.6	35.2	1.5	1.5	1.5	2
F. P. I. 63852	do	Sept. 1	0–2	30	35	107	80.2	35.5	1.5	1	2.5	2
N. J. 97815	do	Aug. 14	2–3	30	46	107	77.1	34.1	1	1.5	4	2
N. J. 92615	do	Aug. 22	2–3	29	49	107	79.2	32.2	1	1	2	2
White-fleshed:												
Belle (Georgia Belle, Belle of Georgia).	W. F. M.	Aug. 10	0–3	40	60	106	79.8	34.8	5	4	1	2.5
Carman	do	July 27	2–3	35	57	106	79.1	32.2	5.5	4	1	3.5
Champion	do	Aug. 7	0–2	42	54	106	81.8	34.8	4.5	3	1.5	2.5
Greensboro	do	July 14	2–3	45	75	108	75.1	33.0	6	9	1	6
Heath	W. C. M.	Sept. 13	0–2	25	42	107	79.7	36.0	4	2	1.5	2
Hiley	W. F. M.	Aug. 3	2–3	42	43	106	78.1	31.1	5	3	1.5	3.5
Hope Farm	do	Aug. 25	2–3	20	45	107	80.2	34.2	3.5	4	1.5	3.
Indian Blood	W. C. S. M.	Aug. 24	2–3	26	50	107	77.6	36.0	9	2.5	3	3
Stump	W. F. M.	Aug. 10	4–5	25	52	106	81.2	31.0	7	5	1	3.5
F. P. I. 36126 (Bolivian Cling).	W. C. M.	Aug. 26	3–4	27	48	107	77.1	32.6	4	2	2	2
N. J. 66	W. F. M.	July 25	0–3	35	65	107	82.2	35.1	7	2	1	4
N. J. 12722	W. C. N. M.	do	0–3	35	50	106	80.2	35.9	5	2	1	2.5

In order to facilitate comparison of the results, the varieties have been divided into a number of groups. The basis of the grouping is arbitrary; the members of each group have such general similarity in character and in behavior under preservative treatment that there is distinct likeness in character and quality of the products made from them. The grounds for the groupings will become apparent in the course of the discussion. A number of varieties which did not clearly fit into any of the other groups were placed together and designated as a miscellaneous group.

YIELDS

The yields stated were determined by weighing the tared pan and contents at the end of the boiling period and expressing the result as a percentage of the total weight of fruit plus the sugar employed. When so stated, the percentage of yield indicates the amount of evaporation which occurred during boiling. It will be noted that the yields of the varieties vary within very narrow limits and that the several groups show no very significant differences. Such differences as occur are felt to be due to variations in sugar content of the fruit used. Since sugar content of the fruit will vary with seasonal conditions and with the load of fruit upon the tree, it is

not believed that the yield differences between varieties here found are reproducible or significant. It is obvious that when boiling is carried to the same temperature, well-grown fruit of high quality will give slightly better yields than inferior material and that yield will increase with advance in ripeness of the fruit. This will not necessarily hold true if the time of boiling is determined by consistency and not by the boiling temperature attained.

CONSISTENCY

As previously stated, the existing standards for preserves leave a rather large range for individual interpretation of their statements about consistency, for which reason the writers adopted an instrumental method for measurement of this factor. While not without some imperfections, the method employed gives closely reproducible results, reveals differences in consistency which are not detectable otherwise, and eliminates errors of individual judgment.

In order to gain an idea of the range in consistency of commercial peach preserves, three rather widely advertised brands, labeled as pure peach preserves, were purchased and subjected to test. One of these, brand A, gave an average consistometer reading of 34.0; brands B and C gave average readings of 37.7 and 37.5, respectively, indicating considerably thinner consistency than brand A. As all three products bore popular brands and enjoy wide distribution, it is assumed that they represent not only the consistency desired by the consumer but also that required by the terms "suitable consistence" or "pulpy or semisolid consistency" of the food standards.

With respect to consistency of the product as determined by the consistometer test, the varieties included in the present studies are divided fairly clearly into two general classes. One of these consists of the melting-fleshed freestone varieties of the dessert type, which as a class show rather heavy consistency, with consistometer readings ranging between 30.0 and 36.0 and averaging about 33.3. The other is made up of clingstone varieties of the nonmelting type of flesh, which as a group show rather thin consistency, with consistometer readings ranging between 32.5 and 39.0 and averaging about 35.0. There is also an intermediate group consisting of both free and cling types, in which the flesh is quite firm and resilient until the fruit is nearly ripe, when it rather rapidly becomes soft and melting. In these varieties the consistency of the product was rather variable, but for the most part it was intermediate between that of the melting and the nonmelting groups.

Of the subgroups into which the melting-fleshed varieties are divided, the Elbertalike group yielded products of somewhat heavier consistency than the other groups. Lovell, Smooth Hale, and Captain Ede were outstanding in this respect, the preserves being too thick and viscous to flow readily when poured from one container to another. They were closely followed by J. H. Hale, Late Elberta, October Elberta, Stump, Hiley, Primrose, and Krummel, all of which had average consistometer readings between 31.0 and 32.0. The products made from varieties of the Crawfordlike group were slightly more liquid and also somewhat more uniform in their consistency than the Elbertalike group. The miscellaneous group,

which consists chiefly of melting-fleshed yellow freestone varieties, has average consistencies ranking closely with those of the Crawfordlike group. In the white-fleshed group, the melting-fleshed freestone varieties give products with consistency readings very similar to those of the Elbertalike and Crawfordlike groups, the nonmelting-fleshed varieties yielding distinctly thinner products with consistometer readings approximating those for the canning group.

The differences in consistency between the varieties are believed to be due to several different causes. The explanation for the consistent difference between the melting-fleshed freestone dessert varieties and the nonmelting clingstone canning types has been shown by the work of Addoms, Nightingale, and Blake (*1*). These authors found that in the course of ripening, the flesh of dessert varieties rather abruptly becomes soft and melting as a result of rapid decrease in thickness of the cell walls, which continues until actual breaking down of some of them occurs with formation of watery areas in the flesh of the fully ripe fruit. In contrast to the melting-fleshed varieties, the cell walls of the canning varieties decrease only slightly in thickness and remain intact, so that watery areas do not form, and the flesh, while softened, is resilient and nonmelting in texture even when very fully ripe. Nightingale, Addoms, and Blake (*14*) showed that these changes in cell walls in the melting-fleshed varieties are accompanied by a rapid decrease in the amount of insoluble protopectin present. In the fully ripe nonmelting-fleshed varieties, the percentage of insoluble protopectin was very much higher and that of soluble pectin materially lower than in the fully ripe melting-fleshed varieties.

This difference in rate of conversion of protopectin to soluble pectin in the two classes of fruits is significant in relation to the consistency of the products. In the melting types, there is extensive conversion of pectic substances into soluble form in the process of ripening, so that pectin is extracted from the fruit in the process of boiling and increases the viscosity of the resulting product. In the nonmelting types, there is much less soluble pectin in the tissues and correspondingly lower viscosity in the finished preserves. It will be noted that high consistometer readings, denoting rather thin consistency, are characteristic not only of the typical nonmelting canning varieties but also of a number of clingstone varieties, for example, Heath, Indian Blood, and some of the New Jersey selections, which ultimately become semimelting when fully ripe. The thinner, more liquid character of the product was evident when the material was stirred with a spatula or poured from one container to another.

Differences in consistency between varieties of closely similar character, as, for example, the members of the Elbertalike group, are probably due to several different causes. In connection with other phases of the work with peaches, a large number of chemical analyses of varieties have been made, and the results indicate that varietal differences in total solids affect consistency, varieties having a high total-solids content tending to make preserves of rather thick, heavy consistency. Differences in stage of maturity of the fruit used are responsible for some of the differences in consistency between varieties of the same type, chiefly through variations in soluble

pectin content. Since the solution of pectin is continuous throughout the ripening process, differences in stage of maturity between varieties or even between two lots of the same variety might be expected to produce differences in soluble pectin content and consequently in consistency. Nonmelting varieties also differ from one another in their rates of softening, undoubtedly as a result of differences in the rate of enzymic solution of cell-wall materials. The method of cooking here employed allowed comparatively little time for diffusion of pectin from the fruit into the sirup, and in the case of nonmelting varieties or less mature samples of other varieties, the pieces of fruit tended to remain intact, thus retaining the pectin and causing the pieces of fruit to be firmer and the sirup more liquid in character. The results would probably have been somewhat different had the fruit been thoroughly cooked before the addition of sugar.

COLOR

The grades upon color assigned to the different varieties are based on the degree of attractiveness of the color, hence they express the personal preferences of the judges. The color of the samples was generally a reddish yellow, which varied considerably in intensity and which in a good many cases had more or less dark brown in it. The dark-brown coloration was considered undesirable while clear bright yellow or reddish yellow was regarded as desirable. As a rule, the more intense the yellow color the more attractive the product was considered, but there were some exceptions in which very bright clear yellows of only medium intensity were given higher ratings than the intense but reddish yellows. Products which received a rating of 1 to 3 on color were considered satisfactory in this respect, while those given a rating of 4 or more were unattractive, usually by reason of the presence of brownish-red to dark-brown coloration.

It will be noted that all the varieties of the canning group were rated as satisfactory in color, as were most of the varieties of the Crawfordlike group. The Elbertalike group was quite variable. Eight members of the group were rated as satisfactory, two of them, Early Elberta and Ideal, being fully equal to any of the canning group in the attractiveness of their clear, bright-yellow color, while the remaining eight received rankings of 3.5 to 5.5 on account of dull reddish-yellow to dark brownish-red coloration. The miscellaneous group contained three varieties, Massasoit, Lovell, and F. P. I. 63850 (a freestone seedling of Shalil introduced from India), which were satisfactory in respect to color; the others were unattractive because of browning.

The white-fleshed group was distinctly inferior in color to any of the other groups; none of its members were considered sufficiently attractive to have market possibilities, while some were so dark as to be distinctly uninviting.

The individual varieties ranking highest in color were chiefly of the yellow-fleshed nonmelting cling type and included Dralle Golden, Golden Queen, Phillips Cling, Motion, Paragon, F. P. I. 55563, and the New Jersey seedlings N. J. 97815 and 92615. Of the yellow melting-fleshed freestones, Early Elberta and Ideal

ranked highest. A second group, only slightly inferior in point of color, was made up of practically all the remaining yellow-fleshed clingstone varieties with Augbert, Late Elberta, Engle, Foster, Kalamazoo, Massasoit, and F. P. I. 63850 of the yellow-fleshed freestone varieties and Rosalind and Sutter Creek of the yellow melting-fleshed clingstones. A small number of varieties received color ratings of 2.5 to 3 and were consequently considered acceptable in this respect; these included Brackett, Elberta, Reeves, and Rochester. The remaining varieties were considered unattractive in point of color, usually as a result of the presence of brownish discoloration, and received ratings of 3.5 to 9 in accordance with the amount and character of the discoloration.

Most of the varieties employed in the present work have been used in freezing experiments by Caldwell, Lutz, Moon, and Myers (*6*). These workers found that when the material was frozen in hermetically sealed containers so that access of air was prevented, the development of brown discoloration was very largely prevented, and the color of the flesh after 5 to 6 months' storage at 17° F. in most varieties was practically that of the freshly prepared fruit of the variety. In the same material packed in liquid-tight, but not airtight, containers a wide range of varietal behavior was observed, a few varieties showing little or no discoloration while the others presented degrees of brown discoloration ranging from moderate to severe.

The results of the freezing experiments with respect to discoloration show little relation to those observed when the same varieties are made into preserves. As a group, the yellow-fleshed clingstones were most satisfactory in color when made into preserves; when frozen in nonairtight containers most of them developed a considerable degree of discoloration. On the other hand, a number of freestones which developed very little discoloration when frozen in nonairtight containers became decidedly brown when made into preserves. Examples are Eclipse, J. H. Hale, Chairs, and Up-to-Date, which retained excellent color when frozen but were given ratings of 3.5 to 7 on color when made into preserves. Some other varieties which developed more discoloration when frozen than those just named, including Brackett, Rosalind, Late Crawford, Slappey, St. John, Reeves, Elberta, Early Elberta, Late Elberta, and Augbert, had excellent color, rating 1 to 2.5 when made into preserves. In the case of the clingstone varieties and a number of the melting-fleshed freestones, it is apparent that the heating of the material in the process of preserving has inhibited the oxidizing mechanism which produces rather extensive discoloration when the material is frozen in containers which do not exclude oxygen. In the case of some other melting-fleshed freestones, it is equally apparent that the heat of processing accelerates the oxidizing process, producing a degree of discoloration very much greater than that occurring when the product is frozen in nonairtight containers. Caramelization was not a factor in the production of this discoloration.

DEGREE OF DISINTEGRATION AND TOUGHNESS OF FLESH

The two factors of degree of toughness of flesh and amount of disintegration are very closely related and may consequently be discussed together.

The judges found themselves unable to agree upon any common standard in judging the factor of disintegration. Some considered that in a commercial product it was essential that the pieces of fruit hold their shape completely, while others considered that partial disintegration of the material would be fully as acceptable as completely intact pieces. Both groups felt that it was essential to an acceptable commercial product that the pieces of flesh should not be tough. In consequence of the differences of opinion as to the effect of disintegration upon quality, the ratings given in the column headed "Disintegration" in table 1 state relative amounts of disintegration and do not express judgments as to desirability or undesirability. In the column headed "Toughness" a rating of 1 to 2.5 was considered as unobjectionable, while ratings of 3 or higher indicate that the material was too tough to be wholly satisfactory.

There were tremendous differences between varieties in the amount of disintegration. In some varieties, as in Greensboro, Carman, and Stump, the identity of the pieces was almost completely lost. In most of the melting-fleshed varieties there was a tendency for the pieces to break down and become ragged, while in the canning group the shape of the pieces was well preserved and their texture in a good many instances was rather firm and tough. In addition to this general difference between the melting and nonmelting types, which was to be expected in view of the differences in the chemistry of ripening found by Addoms, Nightingale, and Blake (*1*, *14*), there were also within each group variations in amount of disintegration and degree of toughness which are characteristic of the variety concerned.

In a number of varieties the pieces were tender and yet had retained their shape well; for example, Early Elberta, Engle, Tuskena, Up-to-Date, Motion, Paragon, Banner, Heath, and F. P. I. nos. 55564 and 55836. In some other varieties there was a considerable degree of disintegration, yet the pieces of flesh were rather tough, as in Rosalind and Primrose. In the great majority of cases, however, a ranking of 1 in toughness was associated with rather extensive disintegration of tissues and rankings of 2.5 to 3 in toughness with fairly complete preservation of shape of the pieces.

In general, the varieties in which considerable disintegration had occurred had better consistency than those in which the pieces of fruit remained largely or entirely intact. On the samples with intact pieces, there was a considerable quantity of sirup surrounding the fruit, and this appeared to be rather too thin to be most desirable.

FLAVOR

Several factors enter into the determination of the flavor of a preserve. Among these are the quality and intensity of the characteristic basic peach flavor, the degree to which individual varietal flavor has been preserved, the balance between sugar and acid, and the pres-

ence or absence of undesirable or foreign flavor. Such flavor when present generally results from alteration in some constituent during cooking. Probably because these several factors are involved, it was generally more difficult for the judges to decide on the ranking to be given on flavor than upon that for any other factor. Consequently the accuracy of the ratings may be more questionable than is the case with those for color.

While there were distinct differences in flavor between varieties and varietal groups, these were not as great as might have been expected on the basis of experience with the fresh fruit and with frozen and canned material. Both the characteristic peach flavor and the individual varietal flavors were to a considerable extent masked or overwhelmed by the sweetness of the products. A few varieties were quite outstanding in the fullness and appeal of their flavor; these were Slappey, Early Elberta, Ideal, and Up-to-Date. A number of others were not quite equal to those just named but were considered excellent in flavor; these included Brackett and Late Elberta, of the Elbertalike group; Early Crawford, Foster, Kalamazoo, and Late Crawford, of the Crawfordlike group; Orange Cling, Tuscan, Paragon, and F. P. I. 55564, of the canning group; and F. P. I. 63850.

As a whole, the Crawfordlike group seemed to have somewhat more of characteristic peach flavor than any other group. The Elbertalike group showed widest variations, chiefly for the reason that several of its members developed quite pronounced objectionable flavors as a result of processing. The white-fleshed varieties and the miscellaneous group ranked lowest, for the reason that none of them retained very much characteristic peach flavor. The canning group ranked high for two reasons—there was an entire absence of any foreign or objectionable flavor resulting from cooking, and there had been fairly good retention of such degree of peach flavor as had been originally present. Consequently the members of the group were very much alike in flavor, having a uniform blandness and sweetness and absence of any pronounced or objectionable flavor which some of the judges preferred to the rather pronounced and characteristic flavors found in many varieties in the Crawfordlike and Elbertalike groups.

COMPARATIVE RANKING OF THE VARIETIES

It is obvious from the preceding discussion that a high degree of excellence in any one factor is not sufficient to make a variety suitable for preserve making. It must possess a certain degree of excellence in each of several qualities, including color, flavor, resistance to disintegration, absence of toughness in texture, and consistency. All of these factors must be considered in evaluating the variety, and it is doubtful whether all the factors named should be given equal weight or whether some are not of greater importance than others. This makes the comparative ranking of a large number of varieties a matter of some difficulty, and the independent judgments of a number of persons would differ somewhat in detail accordingly as one laid more stress on one character, another on another. What is said here, however, represents the accordant opinions of a con-

siderable number of persons who carefully studied and graded the material.

First rank.—Early Elberta, Ideal, Paragon, Tuskena.

Second rank (following the first very closely).—Motion Cling, N. J. 92615, N. J. 97815, Foster, Golden Queen, Kalamazoo, Late Elberta, Orange Cling, Sellers Cling, Phillips Cling, Peakes, F. P. I. nos. 55563, 55564, 55836, and 68354.

Third rank.—These made highly satisfactory products, but for one reason or another were not considered quite equal to the first and second groups. These were Augbert, Brackett, Elberta, Engle, Slappey, Late Crawford, Massasoit, St. John, Dralle Golden, Levy, Goodman Choice, Up-to-Date, Rochester, and A 1.

No attempt was made to rank the remaining varieties into groups, for the reason that all of them were considered deficient in one or more of the qualities essential to the making of a wholly satisfactory product. In the majority of cases, discoloration or disintegration of flesh, or both together, eliminated the variety from consideration, while in occasional cases the loss of normal flavor and the development of foreign flavor was responsible.

EFFECT OF STAGE OF MATURITY OF THE FRUIT

The comparative studies were made with fruit which was as nearly as possible identical in its stage of maturity for all varieties. Since the stage of maturity that is best for preserve making may vary somewhat with variety, a more exact method would have involved the determination of the optimum stage of maturity for each variety and the making of comparisons upon samples each of which was at the stage of maturity found best for that variety. Determination of the optimum stage of maturity for each of the 67 varieties would have demanded an amount of work too large to be accomplished in a single season, hence it was undertaken with a half dozen varieties only. From the character of the results, the writers feel quite confident that the varieties placed in the first and second rank would have proved superior to the others if the ideal procedure just suggested had been followed.

For the studies of effect of stage of maturity upon quality of product, six varieties were so chosen as to represent the various groups of peaches used. They included Engle, of the Crawfordlike group, and Late Elberta and Wilma, of the Elbertalike group of the melting-fleshed freestone type, McDevitt Cling as a representative of the melting-fleshed clingstone type, and Orange Cling and Levy as representatives of the nonmelting-fleshed clingstone type. In the case of Engle, Levy, and Orange Cling, the first sample was taken 2 days before shipping ripeness, the last about 5 days after shipping ripeness, or at the soft-ripe stage, and an intermediate sample about midway between these stages. In the other varieties two samples were taken, these having a difference of 5 or 6 days in their stage of maturity. The results are presented in table 2.

TABLE 2.—*Effect of stage of maturity of fruit upon quality of preserves made from peaches*

Variety	Date harvested	Stage of maturity		Fruit	Sugar	Time required to reach boiling point	Length of boiling period	Temperature at end of boiling period	Yield of total ingredients	Consistency value	Color grade	Disintegration [1]	Toughness [1]	Flavor [1]
		Before shipping ripeness	After shipping ripeness											
		Days	*Days*	*Per-cent*	*Per-cent*	*Min-utes*	*Min-utes*	*°C.* [2]	*Per-cent*					
Engle	Aug. 21	2–0	------	50	50	32	53	107	81.2	33.9	3	1.5	1	2.5
Do	Aug. 24	------	2–3	50	50	27	45	107	79.2	33.8	1.5+	2.0	1	2
Do	Aug. 26	------	3–5	50	50	23	37	107	80.6	32.9	1	3.0	1	2+
Orange Cling	Aug. 24	2	------	50	50	30	55	107	78.6	35.4	5.5	1	4	4.5
Do	Aug. 26	1	1	50	50	30	41	107	80.2	34.5	3.5	1	3	2
Do	Aug. 28	------	2–3	50	50	25	40	107	79.2	35.1	2	1	2	1.5
Do	Aug. 30	------	3–5	50	50	20	40	107	77.6	34.9	1.5	1	1.5	1.5+
Late Elberta	---do----	1–0	------	50	50	24	36	107	80.7	35.6	5	2	3	4
Do	Sept. 5	------	1–3	50	50	25	35	107	80.7	32.0	1.5	4.5	1	1.5
McDevitt Cling	Aug. 30	2–0	------	50	50	39	25	106	80.2	33.0	4	1.5	2.5	4
Do	Sept. 5	------	1–2	50	50	18	42	107	78.6	32.2	2.5	1.5	3	3.5
Wilma	Aug. 30	2–0	------	50	50	27	41	107	80.2	34.5	3.5	2	3	3
Do	Sept. 5	------	1–3	50	50	17	36	107	79.2	32.4	1	5	1.5	2
Levy	Sept. 10	2–0	------	50	50	29	45	107	78.1	36.4	3.5	1	7	3.5
Do	Sept. 13	(3)	(3)	50	50	30	47	107	78.6	36.1	3.5	1	5	3.5
Do	Sept. 18	------	2–5	50	50	29	45	107	79.7	35.0	2	1.5	4	3.5

[1] Rated on scale of 1 to 10; see explanation on p. 5.
[2] Fahrenheit equivalents are as follows: 106° C.=222.8° F.; 107° C.=224.6° F.
[3] Shipping ripeness.

There appear to be no significant differences in yield of finished product from the various lots. The differences in the consistency readings for the samples of differing degrees of ripeness are not large, but there is a general tendency toward lower readings, indicating heavier consistency with increase in maturity. This may be due to greater disintegration of pieces in the riper fruit, which permitted more extensive diffusion of pectin from the tissues into the sirup. The varieties differed very considerably in this respect; the amount of disintegration did not increase with increasing ripeness in Orange Cling and McDevitt Cling and only slightly with Levy, whereas it increased rapidly with the melting-fleshed varieties Engle, Late Elberta, and Wilma.

The most striking difference observed in the various lots with advance in maturity was the change in character and intensity of the color, which steadily improved. In the earlier stages of maturity there was in all the varieties a conspicuous dark shading of the finished preserve, which decreased or disappeared completely as the fruit became more mature. The yellow color also appeared to increase in intensity up to full soft ripeness of the fruit. The changes in these two respects combine to give the preserves made from fully ripened fruit decided superiority in color. In every variety the flavor was considered better in the riper product.

It will be clear from the foregoing paragraphs that the best stage of maturity for preserve making is not identical for all varieties and that it will be somewhat different for melting-fleshed and nonmelting-fleshed types. In both types, improvement in color and flavor is progressive as the fruit becomes more mature. In

the melting-fleshed types, disintegration of the tissues also becomes more pronounced as ripening advances, whereas little change occurs in the nonmelting-fleshed types. Consequently, the best stage for preserving in the nonmelting varieties, Orange Cling and Levy, was 3 to 5 days past shipping ripeness. In the melting variety, Engle, the best stage was 2 to 3 days past shipping stage. This stage represents a compromise between two opposing factors; color and flavor continue to improve as the fruit becomes still riper, but their effect is off-set by the increase in distintegration which occurs during preparation and cooking.

EFFECT OF CONTINUING COOKING TO VARIOUS END POINTS

The variety Elberta was employed in this experiment. A large quantity of fruit was carefully sorted for uniformity in stage of maturity. Equal quantities of fruit and sugar were used in all cases, and the details of preparation and handling were as nearly identical as it was possible to make them for all lots except that the boiling was discontinued at various end points. Boiling of lot 1 was discontinued when the boiling point had reached 104° C.; that of the second lot was continued to 105°; and that of each subsequent lot was carried 1° higher up to lot 6, which was boiled to an end point of 109°. The results are shown in table 3.

TABLE 3.—*Effect of boiling to various end points upon quality of preserves made from Elberta peaches and 50 percent sugar*

[Stage of maturity of fruit, 2 or 3 days past shipping ripeness]

Date harvested	Time required to reach boiling point	Length of boiling period	Temperature at end of boiling period		Yield of total ingredients	Consistency value	Color grade [1]	Disintegration [1]	Toughness [1]	Flavor [1]
	Minutes	*Minutes*	*° C.*	*° F.*	*Percent*					
Aug. 21	35	33	104	219.2	84.9	38.5	1.5	1.5	1.5	1.5
Do	30	37	105	221.0	80.7	37.0	2	2	1.5	2
Do	25	40	106	222.8	78.6	35.0	2.5	2.5	2	2.5
Aug. 16	25	39	107	224.6	75.5	33.0	2.5	2.5	2	2.5
Aug. 21	33	48	108	226.4	73.4	30.8	3	3	2	3
Do	23	46	109	228.2	71.0	28.1	3.5	3	2	3.5

[1] Rated on scale of 1 to 10; see explanation on p. 5.

It will be observed that the length of the boiling period was not constant but tended to increase with increase in the end-point temperature, although the increase is not a regular or orderly one. Since the elevation of the boiling point is brought about through the driving off of water, the yield of finished product decreases as the end-point temperature is raised. The yield in the lot boiled to 104° C. was 84.9 percent of the weight of fruit plus sugar: the yield in the lot boiled to 109° was 71 percent. In the case of pure sugar solutions, a solution boiling at 104° contains 64 percent of sugar; one boiling at 109° contains 75 percent. As the fruit contains other constituents that affect the boiling point of a preserve, its boiling point cannot be regarded as an exact measure of its sugar content, but rather as an approximation.

The batch boiled to 104° had a consistency value of 38.5 and was entirely too thin, consisting of pieces of fruit floating in a liquid sirup. The density of the material increased rather regularly with increase in end-point temperature, the batch boiled to 109° having a consistency value of 28.1. It was practically solid. The lots boiled to 106° and 107°, which had consistency values of 35.0 and 33.0, respectively, were regarded as most satisfactory in consistency.

The color became progressively less attractive as the end-point temperature was increased. While the yellow color became more intense at the higher end points, darkening and browning also occurred and decreased the attractiveness of the product. The amount of disintegration also increased considerably at the higher end points. A rating of 1.5 was given the batch boiled to 104° C. and one of 3 to that boiled to 109°, but there was little increase in toughness. The pieces of fruit which remained intact seemed slightly harder in texture in batches boiled to end points higher than 106°.

The flavor of the product was progressively altered as the end point of boiling was raised. The natural peach flavor was greatest in the 104° C. batch and became less pronounced in subsequent batches. No objectionable flavor was developed in any lot except that boiled to 109°, in which a somewhat disagreeable caramelized flavor was perceptible.

The boiling point to which the cooking of a preserve should be carried is determined very largely by the consistency which the finished product must have. In this test, the batch boiled to an end point of 107° C. was regarded by the judges as slightly superior in consistency to that boiled to 106°, although the two were given identical ratings in other respects.

It appears that for a mixture of equal parts of fruit and sugar without added water, such as was employed in these tests, boiling to an end point of 107° C. will give a product of desirable consistency in the case of the melting-fleshed varieties of peaches. If the non-melting-fleshed types are being used, products of better consistency will be obtained by continuing the boiling to 108° as end point. If other proportions of fruit to sugar than 50-50 are used, some change in boiling end point may be necessary.

EFFECT OF VARYING THE PROPORTION OF FRUIT TO SUGAR

The Elberta variety was used in these tests. The fruit was carefully selected for uniformity in stage of maturity, and the various details of preparation and treatment were as uniform as it was possible to make them. The various lots were boiled to an end point of 107° C., an attempt being made to keep the rate of boiling uniform for all lots. This, of course, resulted in an increase in boiling time as the proportion of sugar to fruit was decreased. With 58.3 percent of sugar the boiling time was only 20 minutes, whereas with 41.7 percent of sugar it required 56 minutes of boiling to reach the end point of 107 °(table 4).

TABLE 4.—*Effect of varying proportions of fruit and sugar upon quality of preserves made from Elberta peaches*

[Harvested Aug. 21; stage of maturity of fruit, 2 or 3 days past shipping ripeness; temperature at end of boiling period, 107° C. (224. 6° F.)]

Fruit	Sugar	Time required to reach boiling point	Length of boiling period	Yield of total ingredients	Consistency value	Color grade [1]	Disintegration [1]	Toughness [1]	Flavor [1]
Percent	*Percent*	*Minutes*	*Minutes*	*Percent*					
41.7	58.3	19	20	91.5	37.5	1.5	2	2	3
45.8	54.2	27	48	80.2	36.7	1.5	2	2	2.5+
50.0	50.0	25	32	75.5	33.0	2.5	2.5	2.5	2.5
54.2	45.8	31	62	69.8	31.6	2.5	3	2.5	2.5
58.3	41.7	20	56	66.1	29.7	3.5	3.5	2.5	3.5

[1] Rated on scale of 1 to 10; see explanation on p. 5.

The lowest percentage of fruit used was intentionally placed below the permissible minimum of 45 percent fixed by standards of the Food and Drug Administration (*16*), the next, 45.8 percent, just exceeds the standard, and the quantity of fruit in subsequent batches increased by steps of approximately 4 percent up to 58.3 percent.

The yield of finished preserve expressed as percentage of total ingredients varied greatly with variation in the proportion of fruit to sugar, decreasing as the proportion of fruit in the mixture was increased. In the batch with 41.7 percent of fruit the yield was 91.5 percent; in that with 58.3 percent of fruit it was only 66.1 percent. Had other varieties been employed, the yields for the various proportions of sugar to fruit would probably have shown varietal differences of the same order as are shown by the 50-50 mixtures of table 1.

Consistency also varied considerably as the proportion of fruit to sugar was varied. The batch containing 41.7 percent of fruit had a consistency value of 37.5 and was distinctly too thin; that containing 58.3 percent of fruit had a value of 29.7. The progressive increase in density with increasing amounts of fruit is due to the larger quantities of pectins and other colloidal materials present in the larger quantity of fruit and to the concentration resulting from evaporation during the longer boiling necessary to reach the end point.

Color was distinctly lighter and brighter in the batches containing 41.7 and 45.8 percent of fruit than in those having larger amounts. As the proportion of fruit was increased the yellow color became more intense but also became darkened and browned. This was apparently due to the larger quantities of oxidizable substances present, the higher acidity, and the longer period of boiling.

Disintegration of the tissues increased, as did the toughness of the intact pieces of fruit, with increase in the proportion of fruit present in the batch, probably because of the increase in length of the cooking period.

There were considerable differences in flavor of the various batches. It had been expected that the flavor would become increasingly agreeable with increase in amount of fruit used, but this was not the case. The batch containing 45.8 percent of fruit was

regarded as most pleasing in flavor, while that having 41.7 percent was considered lacking in flavor and in acidity and as being too sweet. In the batches having 50 percent or more of fruit the flavor was somewhat altered as a consequence of the higher acidity, the larger content of oxidizable material, and the longer boiling period. The batch containing 58.3 percent of fruit was too acid, somewhat strong in flavor, and was slightly caramelized.

When all factors were considered, it was the decision of the judges that the product made from equal parts of fruit and sugar was the most desirable.

The exact proportions of fruit and sugar which will yield the best product will probably vary somewhat with the variety. From the comparative results with varieties it would appear that the nonmelting-fleshed types might advantageously have a slightly higher proportion of fruit to sugar than the melting-fleshed types. In the case of varieties which are low in acidity a somewhat larger proportion of fruit to sugar would give a better balance of sugar and acidity and would improve the flavor of the product. Moon and Culpepper (*12*) have shown that the same general principles apply in the making of preserves from Kieffer pears.

SUMMARY

Preserves were made from 67 varieties of peaches, including about 40 freestone varieties having flesh which becomes soft and melting as the fruit ripens, 20 clingstone canning varieties having nonmelting flesh, and some intermediate semimelting varieties. The fruit used was of approximately the same stage of maturity, and the details of preparation and cooking were as nearly identical as it was possible to make them. The finished products were individually graded for the factors of consistency, color, degree of disintegration of fruit, texture of fruit, and flavor.

There were distinct differences between the products made by this method from varieties of the melting-fleshed type and those of the nonmelting-fleshed type which are clearly due to the differences in the ripening processes in the two types. As a group, the nonmelting-fleshed varieties made preserves having clearer, more attractive color, distinctly less disintegration of fruit, somewhat firmer, tougher texture, thinner consistency, and less pronounced and distinctive flavor than the melting-fleshed varieties considered as a group. These differences are attributable to the very much greater solution of cell walls and formation of soluble pectin which occurs during ripening in the melting-fleshed types.

There were also within each group very considerable differences between varieties in their suitability for preserve making by the method used. When all factors were considered, Early Elberta, Ideal, Paragon, and Tuskena were considered slightly superior, but were rather closely followed by Motion Cling, N. J. 92615, N. J. 97815, Foster, Golden Queen, Kalamazoo, Late Elberta, Orange Cling, Sellers Cling, Peakes, Phillips Cling, and F. P. I. nos. 55563, 55564, 55836, and 68354. Products which were entirely satisfactory but which were not quite equal in one respect or another to those just listed were yielded by Augbert, Brackett, Engle, Elberta, Slappey,

Late Crawford, Massasoit, St. John, Dralle Golden, Levy, Goodman Choice, A 1, Up-to-Date, and Rochester.

Varieties of closely related groups, as the Crawfordlike group or the Elbertalike group, showed marked differences in color, texture, and consistency, and flavor of the product, emphasizing the fact that individual varietal characters determine suitability for preserving purposes.

There were only insignificant differences in final yield expressed as percentage of total ingredients when boiling was carried to a uniform end point of 107° C. Such differences as occurred are probably due chiefly to differences in water content of the fruit used.

The quality of the product varied greatly with the stage of maturity of the fruit used. In all varieties tested there was a progressive improvement in color and flavor with advancing maturity. In the melting-fleshed varieties there was also an increase in disintegration of tissues and a slightly thickened consistency, which was not apparent in the nonmelting-fleshed sorts. The best stage of maturity for preserve making is one in which the fruit is as ripe as can be prepared and cooked without undergoing too extensive disintegration. For melting-fleshed varieties this stage will be 2 to 3 days past shipping ripeness; for nonmelting-fleshed varieties, 4 to 5 days past that condition.

Varying the proportion of fruit to sugar produced marked differences in color, consistency, and flavor of the product. When the various lots were boiled to the same end-point temperature, increasing the proportion of fruit in the mixture increased the consistency and decreased the yield. As the proportion of fruit was increased, the boiling period necessary to bring the batch to end-point temperature was increased, and color and flavor were injured by the longer heating. For lots of Elberta containing 41.7 to 58.3 percent of fruit, all boiled to 107° C., the best product was that containing 50 percent of fruit.

Varying the time of cooking produced marked differences in consistency, color, and flavor of product from identical lots of material. In batches in which cooking was continued to end points ranging from 104° to 109° C., color and flavor were best in the lot boiled to an end point of 104°, but the product was too thin. Consistency became progressively heavier, yield decreased, and flavor and color fell off as the temperature at end of boiling was increased. The product boiled to 109° was too heavy, somewhat caramelized in flavor, and dark in color. All factors considered, the product made by boiling to an end point of 107° was most satisfactory.

An instrumental method of measuring consistency of the finished product was used. It employs the depth to which a weighted cone sinks into the product in a measured interval of time as a measure of consistency. The results agree closely with estimates of consistency arrived at by other methods, and the instrumental method appears to have promise of usefulness in the measurement of consistency in other fruit preserves. It has already been employed with satisfactory results upon pear preserves (*12*).

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U. S. GOVERNMENT PRINTING OFFICE: 1935

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

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